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1d29103

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification⁶ : H05K 3/06	A1	(11) International Publication Number: WO 97/15173 (43) International Publication Date: 24 April 1997 (24.04.97)

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"radical" refers to the inclusion of only pure hydrocarbon chains such as methyl, ethyl, propyl, cyclohexyl, isooctyl, *tert*-butyl, and the like.

Other aspects, advantages, and benefits of the present invention are apparent from the detailed description, the examples, and the claims.

5 Detailed Description of the Invention

 The donor element is composed of a suitable substrate coated with a layer of resist material containing: a light-to-heat converter (such as carbon black) dispersed in a binder. An optional adhesive layer can be on top of the resist layer. The carbon black or other material functions as a light-to-heat converter upon
10 exposure to incident electromagnetic radiation and causes a rapid local heating of the binder. Volatilization of binder components leads to the transfer of resist material to the metal-coated surface of the receiving element. The donor element may be provided in any convenient form such as sheets or rolls.

 The substrate of the donor element may be any substance upon which the
15 resist material may be coated to prepare the donor element. Preferably, the substrate is transparent (at least transmissive) to the wavelength of light used to induce the transfer of the resist material to a metal-coated surface of a receiving element. Possible substrates include glass, polymeric film, and the like. Possible polymeric substrates include polyester base (e.g., polyethylene terephthalate,
20 polyethylene naphthalate), polycarbonate resins, polyolefin resins, polyvinyl resins (e.g., polyethylene, polypropylene, polyvinyl chloride, polyvinylidene chloride, polyvinyl acetals, and copolymers thereof), hydrolyzed and unhydrolyzed cellulose ester bases (e.g., cellulose triacetate, cellulose acetate), and other conventional polymeric films used as supports in various imaging arts. A transparent polymeric
25 film base of 0.5 to 100 mils is preferred (0.001 to 0.254 cm). Typical examples are those derived from polymers containing repeating, interpolymerized units derived from 9,9-bis-(4-hydroxyphenyl)-fluorene and isophthalic acid, terephthalic acid or mixtures thereof, the polymer being sufficiently low in oligomer (i.e., chemical species having molecular weights of about 8000 or less) content to allow
30 formation of a uniform film. This polymer has been disclosed as one component in a thermal transfer receiving element in U.S. Pat. No. 5,318,938. In the laser-

induced process, the donor substrate is preferably transparent polyethylene terephthalate (PET). In the flash lamp-induced process, the donor substrate is preferably a UV transparent material such as polypropylene.

Preferred binders used in the resist material in the present invention are
5 organic-based binders.

The particular binders chosen will depend upon the type of application the end-user desires. Thermoplastic or thermosetting resins may be used as appropriate. Non-limiting examples of thermoplastic polymers are poly(methyl methacrylate), nitrocellulose, ethylene-vinyl acetate copolymer, polyethylene,
10 ethylene-propylene copolymer, ethylene-acrylate copolymer, acrylic rubber, polyisobutylene, atactic polypropylene, poly(vinyl butyral), styrene-butadiene, polybutadiene, ethylcellulose, polyamides, polyurethanes, and polychloroprene. Non-limiting examples of thermosetting resins are epoxy resins, phenoxy resins, cyanate ester resins, acrylic resins, and the like.

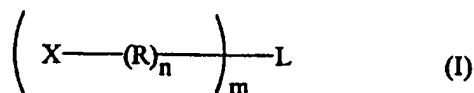
15 In the laser-induced process, when an organic binder is utilized, it is preferably one that exhibits suitable physical properties for transfer of thin films. For example, it is preferred that the imaged area readily releases from the surrounding unimaged area and transfers completely to the metal-coated receptor surface.

20 When an organic polymer is used as a binder in flash lamp-induced transfer, gas-producing polymers are preferred. The heating of the binder during the flash lamp exposure causes a partial or total decomposition of the gas-producing polymer. The resultant gas serves to propel the resist from the donor element to the metal-coated layer of the receiving element. Generally, the gas-
25 producing polymer should have a thermally-available nitrogen content greater than about 10 weight percent; preferably greater than about 20 weight percent; and more preferably greater than about 30 weight percent.

The gas-producing polymer may be any polymer that liberates nitrogen gas (N₂) when heated rapidly, such as, for example, by exposure to an infrared laser
30 beam. Polymers that liberate nitrogen gas on heating generally have thermally-decomposable functional groups. Non-limiting examples of suitable thermally-

decomposable functional groups include azido, alkylazo, diazo, diazonium, diazirino, nitro, nitrato, triazole, etc. The thermally-decomposable groups may be incorporated into the gas-producing polymer either prior to polymerization or by modification of an existing polymer, such as, for example, by diazotization of an aromatic amine (e.g., with nitrous acid) or diazo transfer with tosyl azide onto an amine or β -diketone in the presence of triethylamine.

In one preferred embodiment, the azide-containing polymer used as one of the reactants has the following formula:



wherein:

X represents a hydroxyl, azide, mercapto, or amino (including mono-alkyl and aryl-substituted amino) group and preferably, X is an azide or a hydroxyl group;

R represents a divalent monomer group, containing a N_3 group, derived from a cyclic ether such as, for example, $-\text{CH}_2\text{CH}(\text{CH}_2\text{N}_3)\text{O}-$, $-\text{CH}_2\text{C}(\text{CH}_3)(\text{CH}_2\text{N}_3)\text{CH}_2\text{O}-$, $-\text{CH}(\text{CH}_2\text{N}_3)\text{CH}_2\text{O}-$, $-\text{CH}_2\text{C}(\text{CH}_2\text{N}_3)_2\text{CH}_2\text{O}-$, $-\text{CH}(\text{CH}_2\text{N}_3)\text{CH}(\text{CH}_2\text{N}_3)\text{O}-$, and $-\text{CH}_2\text{CH}(\text{N}_3)\text{CH}_2\text{O}-$; a cyclic sulfide such as, for example, $-\text{CH}_2\text{CH}(\text{CH}_2\text{N}_3)\text{S}-$, $-\text{CH}_2\text{C}(\text{CH}_2\text{N}_3)_2\text{CH}_2\text{S}-$, $-\text{CH}(\text{CH}_2\text{N}_3)\text{CH}(\text{CH}_2\text{N}_3)\text{S}-$, and $-\text{CH}_2\text{CH}(\text{N}_3)\text{CH}_2\text{S}-$; and a cyclic amine such as, for example, $-\text{CH}_2\text{CH}(\text{CH}_2\text{N}_3)\text{NR}^1-$, $-\text{CH}(\text{CH}_2\text{N}_3)\text{CH}_2\text{NR}^1-$, $-\text{CH}_2\text{C}(\text{CH}_2\text{N}_3)_2\text{CH}_2\text{NR}^1-$, $-\text{CH}(\text{CH}_2\text{N}_3)\text{CH}(\text{CH}_2\text{N}_3)\text{NR}^1-$, and $-\text{CH}_2\text{CH}(\text{N}_3)\text{CH}_2\text{NR}^1-$;

R^1 represents a hydrocarbyl group (e.g., alkyl, aryl, aralkyl, alkaryl, etc.);

L represents a mono-, di-, tri- or tetra-valent alkyl radical. Non-limiting examples of monovalent radicals are methyl and ethyl. Non-limiting examples of polyvalent alkyl radicals are ethylene, methylene, propylene, 1,2,3-propanetriyl, 2-ethyl-2-methylene-1,3-propanediyl, 2,2-dimethylene-1,3-propanediyl, etc. Preferably, L is 2-ethyl-2-methylene-1,3-propanediyl;

corresponding to L, m represents 1, 2, 3, or 4; and

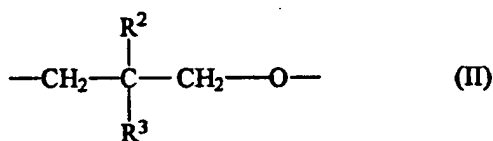
n represents any positive integer greater than 1, preferably greater than 5, more preferably greater than 10.

The foregoing azide-containing polymer of Formula (I) can be made by procedures well known to those skilled in the art of synthetic organic chemistry such as disclosed, for example, in U.S. Pat. Nos. 3,645,917 and 4,879,419.

One or more crosslinking agents may be employed in combination with the azide-containing polymer of Formula (I) to provide coatings having improved strength. The choice of an appropriate crosslinking agent depends on the functional groups on the azide-containing polymer. Thus, if hydroxyl groups are present on the azide-containing polymer, then crosslinking agents for polyols could be employed (e.g., isocyanates). In cases where free-radically polymerizable groups, such as acrylates, are attached to the polymer backbone, a free-radical initiator may be used as a crosslinking agent.

Preferably, a crosslinking agent for polyols is employed in combination with an azide-containing polymer having multiple hydroxyl end groups. Preferred crosslinking agents in this case are polyisocyanates, including but not limited to, hexamethylene diisocyanate; diphenylmethane diisocyanate; bis(4-isocyanatocyclohexyl)methane, 2,4-toluene diisocyanate, etc.

In another preferred embodiment, the azide-containing polymer used as one of the reactants has recurring units of the following formula:



wherein: R² or R³ each independently represent an N₃-containing group. An example of a preferred azide group is -CH₂N₃.

The azide-containing polymer of Formula (II) can be made by procedures well known to those skilled in the art of synthetic organic chemistry such as disclosed, for example, in U.S. Pat. No. 3,694,383.

In another preferred embodiment, energetic copolymers are utilized as reactants having repeating units derived from different monomers, one or more of

which have N_3 groups. Preferably, the monomers are cyclic oxides having three to six ring atoms. Copolymerization of the monomers is preferably carried out by cationic polymerization. The foregoing copolymers and their method of preparation are disclosed in U.S. Pat. No. 4,483,978.

5 The light-to-heat converter serves to convert incident electromagnetic radiation into thermal energy. For this reason it is generally desirable that the radiation absorber have low fluorescence and phosphorescence quantum efficiencies and undergo little or no net photochemical change upon exposure to electromagnetic radiation. It is also generally desirable for the radiation absorber
10 to be highly absorptive of the incident radiation so that a minimum amount can be used in coatings. Non-limiting examples of radiation absorbers include pigments such as carbon black (i.e., acetylene black, channel black, furnace black, gas black, and thermal black), bone black, iron oxide (including black iron oxide), copper/chrome complex black azo pigments (e.g., pyrazolone yellow, dianisidine
15 red, and nickel azo yellow), black aluminum, and phthalocyanine pigments. In addition to pigments, the radiation absorber may be a dye as described, for example, in M. Matsuoka *Absorption Spectra of Dyes for Diode Lasers*: Bunshin Publishing Co.; Tokyo, 1990.

 Preferably, the radiation absorber employed in the donor element absorbs
20 in the near-infrared or infrared region of the electromagnetic spectrum. In some instances, it may be desirable to employ absorbers which absorb in the visible region of the electromagnetic spectrum.

 Other material that may be included in the resist material of the present invention include dyes such as those listed in Venkataraman, *The Chemistry of*
25 *Synthetic Dyes*, Academic Press, 1970: Vols. 1-4 and *The Colour Index Society of Dyers and Colourists*, Yorkshire, England, Vols. 1-8 including cyanine dyes (including streptocyanine, merocyanine, and carbocyanine dyes), squarylium dyes, oxonol dyes, anthraquinone dyes, and holopolar dyes, polycyclic aromatic hydrocarbons, etc.

30 The donor elements may be prepared by introducing the components for making the resist material layer into suitable solvents (e.g., tetrahydrofuran (THF),

methyl ethyl ketone (MEK), water, toluene, methanol, ethanol, n-propanol, isopropanol, acetone, etc., and mixtures thereof); mixing the resulting solutions at, for example, room temperature; coating the resulting mixture onto the substrate; and drying the resultant coating, preferably at moderately elevated temperatures.

- 5 The resist material may be coated on the donor element by a variety of techniques known in the art including, but not limited to, coating from a solution or dispersion in an organic or aqueous solvent (e.g., bar coating, knife coating, slot coating, slide coating, roll coating, curtain coating, spin coating, extrusion die coating, etc.), vapor coating, sputtering, gravure coating, etc., as dictated by the requirements of the resist material itself.
- 10

The adhesive layer is an optional topcoat which serves to provide enhanced adhesion to the substrate. Any conventional adhesive formulation can be used including, but not limited to, silicones, acrylates, ethylene/vinyl chloride blends, etc.

- 15 When organic polymers are used as binders, it has been found that a topcoat of an adhesive such as those sold under the trade designation Daratak 90L from W.R. Grace & Co., Owensboro, KY (an aqueous dispersion of vinyl acetate-diethyl maleate-2-ethylhexyl acrylate polymer, available from Hampshire Chemical Co., Lexington, MA, 55 wt% solids) often dramatically increases the uniformity of resist transfer as well as improving the adhesion of the resist layer to the metal-coated surface of the receptor during the process steps which follow (e.g., etching, plating-up). The adhesive topcoat may be applied by conventional coating methods including, but not limited to, curtain coating, knife coating, slot coating, extrusion coating, wire-wrapped bar coating, etc.
- 20

- 25 The receiving element comprises a metal surface, usually a thin metal surface on a support to give the element adequate strength for processing and handling. Commonly used receiving elements comprise a metal-coated surface on a non-conductive support. The receiving element may comprise any convenient form such as a sheet, film, or flexible carrier web.

- 30 The support of the receiving element may be any conventional support known to those skilled in the art. Non-limiting examples include polymeric

materials (e.g., PET, polyethylene naphthalate, polyimide, etc.); glass; epoxy materials; ceramic materials; composite materials for printed circuit boards; and paper. It is also possible to laminate copper foil to the receiving element by using a suitable adhesive.

5 Metal-coating or metal-plating can be accomplished by any method known to those skilled in the art such as sputtering, magnetron ion plating, ion enhanced plating, chemical vapor deposition, and electroless plating. Non-limiting examples of metals which can be coated or plated include copper, nickel, tin, aluminum, silver, gold, or alloys thereof.

10 The thermal transfer donor element of the present invention is used by placing it in intimate contact (e.g., vacuum hold-down) with a receptor sheet and imagewise heating the thermal transfer donor element. The radiation absorber utilized in the donor element of the present invention acts as a light-to-heat converter. A variety of light-emitting sources can be utilized to provide the
15 radiation source including lasers and flash lamps.

 A variety of lasers such as excimer lasers, gas lasers (e.g., argon-ion, krypton-ion, etc.), diode lasers, and solid state lasers (e.g., Nd:YAG, Nd:YLF, Nd:Glass, etc.) may be used as a source of the electromagnetic radiation to induce transfer of the resist material to the metal surface of the receptor. Preferred lasers
20 typically have output powers greater than 100 mW. Lasers emitting a variety of wavelengths may be used in the present invention, including ultra-violet, visible, and infra-red lasers (i.e., wavelengths from 250-1300 nm). The preferred lasers for use in this invention include continuous-wave high power (> 100 mW) laser diodes, fiber-coupled laser diodes, laser diode arrays, and lamp or diode-pumped
25 solid-state lasers, with the solid-state lasers (e.g. diode or diode-pumped) being most preferred. With continuous-wave lasers, the exposure dwell time should be in the range of 0.1 to 50 microseconds, with 0.1 to 10 microseconds preferred. Alternatively, a pulsed laser (such as a Q-switched Nd:YAG) may be utilized, in which case the dwell time is the same as the pulse width, which is typically on the
30 order of 1-10 nanoseconds. Laser fluences are usually on the order of 0.1-5 J/cm².

Flash lamps such as xenon flash lamps provide a momentary intense burst of radiation. A xenon flash lamp produces a broad spectrum of bluish white light in a flash of about 2 to 3 milliseconds in duration as described in U.S. Pat. No. 3,914,775. The flash from a xenon flash lamp will provide an amount of radiant energy which is dependent on the electrical energy input from its power supply. The efficiency of the irradiation means in converting energy input to a xenon lamp to radiant flux density received by the material being irradiated is, among other factors, dependent upon the configuration of the lamp, the spacing of the lamp from the material, and the efficiency and configuration of the reflector used in the lamp.

The source of electromagnetic radiation is used to imagewise irradiate the donor element containing the resist material, thereby inducing the transfer of the resist material to the metal-coated surface of the receptor element in the desired pattern. The imagewise exposure may be carried out in any convenient manner as desired. However, in the case of lasers, the imagewise exposure is generally either made by using masks or by directly digitally addressing the laser. Preferably, the laser is digitally-addressed and is capable of writing an arbitrary pattern of resist material on the metal-coated receptor surface. In this situation, the pattern can easily be designed to match the printed circuit application desired. In the case of flash lamps, the imagewise exposure is generally made either by using masks or by focusing the flash with a microlens array.

Masks may be prepared by conventional methods known in the art such as through the use of a photoresist/etching process. The mask is usually made of a material that reflects the incident radiation, and can be coated or deposited on a flexible or a rigid substrate. Materials commonly used to reflect the incident radiation include chrome and/or chrome oxide.

The use of microlens arrays to prepare the patterned resist is amenable to commercial production of a fixed grid resist pattern. Microlens arrays may be fabricated by the well-known method of compression molding of optical thermoplastics such as polycarbonate and poly(methyl methacrylate), PMMA, as described in U.S. Pat. No. 5,300,263. When a flash lamp is used, the binder used

in the donor element should be one which evolves nitrogen gas upon heating. Examples of such binders are disclosed earlier herein.

Any wet chemical etching technique known to those skilled in the art can be used in the present invention. For example, solutions of nitric acid; hydrogen chloride; sulfuric acid and hydrogen peroxide; ferric chloride; or cupric chloride
5 may be used.

The transferred resist may be removed from the metal-coated substrate by any conventional method known to those skilled in the art.

The following non-limiting examples further illustrate the present
10 invention.

EXAMPLES

Internal Drum System

Imaging was performed using an Nd:YAG laser, operating at 1.06 μm in TEM₀₀ mode and focused to a 26 μm spot ($1/e^2$) with 3.5 W of incident radiation
15 at the image plane. The laser scan rate was 64 m/sec. Image data was transferred from a mass-memory system and supplied to an acousto-optic modulator which performs the imagewise modulation of the laser. The image plane consists of a 135° drum which was translated synchronously perpendicular to the laser scan direction.

20 Microlens Arrays

Two different microlens arrays were used. The stamper for the compression molding is a replica of the original tooling, which is fabricated according to the method of U.S. Pat. No. 5,300,263.

Microlens A is an array of spherical lenses, each with a rectangular cross-section 0.33 x 0.11 mm, and was compression molded in 0.007 in. thick
25 polycarbonate at 170°C and 500 psi ($3.4 \times 10^6 \text{ N/m}^2$) for 5 minutes. Microlens B is an array of spherical lenses, each of square 0.356 mm cross-section, and was compression molded in 0.007 in. (0.018 cm) thick polycarbonate at 180°C and 300 psi ($2.1 \times 10^6 \text{ N/m}^2$) for 3 minutes. Both Microlens A and B have focal
30 lengths in air of approximately 1 mm.

Copper Plated Substrates

Copper sputtered (2000 Å thick) polyimide film available under the trade designation Kapton from E.I. duPont de Nemours, Wilmington, DE, was used as a thin metal-coated substrate. A chrome layer had previously been deposited onto the Kapton film before the thin layer of copper was deposited. A thick substrate was prepared by electroplating the thin substrate with 150 µin. (4 µm) of copper. The copper surface was cleaned by swabbing with cotton soaked in the etching solution, rinsing with water, and drying.

Donor Sheet

47.17 wt% black pigment available under the trade designation Raven 760 from Columbian Chemicals Co., Tulsa, OK; 47.17 wt% styrene/acrylic resin available under the trade designation Joncryn 690 from Johnson Wax Co., Racine, WI; and 5.66 wt% dispersant available under the trade designation Disperbyk 161 from Byk Chemie was used directly as an 18.8 wt% solids dispersion in Solvent PM (methoxylated propylene glycol) / MEK (3:1). The dispersion was coated onto plain 4 mil PET using a #4 or a #8 Mayer bar (available from R&D Specialties, Webster, NY) and then dried for 2 min at 55°C. A topcoat of Daratak 90L adhesive was applied using a #4 Mayer bar. The donor sheet was dried again for 2 min at 55°C.

Nitric Acid Etching Bath

An acidic etching bath was prepared by diluting concentrated nitric acid with an equal volume of water.

Sulfuric Acid/Peroxide Etching Bath

An acidic etching bath was prepared by diluting 50 ml of concentrated sulfuric acid with 400 ml of water and 50 ml of aqueous hydrogen peroxide.

Example 1

The copper plated Kapton polyimide receptor (thin substrate) was placed in the curved focal plane surface (internal drum) of the laser imager with the copper surface away from the drum. The donor sheet disclosed earlier herein containing Raven black pigment was placed onto the copper surface so that the copper and resist were in contact and the donor was imaged to create circuit and

line patterns. Lines of 30 μm width and 42 μm pitch were demonstrated to be feasible with this method.

The metal surface was patterned by etching the exposed copper with the sulfuric acid/peroxide bath for approximately 3 min at room temperature to completely remove the metal, leaving only the substrate polymer in the areas that did not receive the resist. The resist was removed by wiping with a cotton swab soaked in MEK, but could also be removed by treatment in a basic aqueous solution. The result of the process is a copper circuit on a Kapton polyimide substrate. Photographs of the patterned samples were taken that showed pattern reproducibility and line edge integrity.

Example 2

3M biaxially-oriented 2 mil PET containing slip agent on the opposite side of the vapor coating was sputtered with approximately 5 nm Inconel 600 (alloy of chromium, iron, and nickel) and then vapor coated with approximately 75 nm of copper.

A mixture of 5 g of Daratak 90L adhesive and 45 g of isopropanol/MEK (2:1) was agitated vigorously for 20 min on a shaking table. The resulting translucent adhesive solution was used directly as described below.

An aqueous dispersion (Penn Color, Doylestown, PA, #RD-35088-30, 35% solids) consisting of carbon black, water-soluble acrylic resin available under the trade designation Elvacite 2776 from ICI Acrylics (pigment/binder weight ratio of 1:1), and dimethylethanolamine was coated onto plain 4 mil PET using a #4 Mayer bar and then dried for 3 min at 80°C. A topcoat was applied by coating the adhesive solution using a #3 Mayer bar and drying the sample for 1 min at 80°C.

The copper-coated PET film was placed in the curved focal plane surface (internal drum) of the laser imager with the copper surface away from the drum. The donor sheet was placed onto the copper surface so that the copper and resist were in contact and the donor was imaged to create circuit and line patterns.

The transferred resist pattern on copper-coated PET was the negative of the circuit pattern. An additional 2-10 μm of copper was electroplated onto the

vapor coated seed layer using a standard printed circuit board sulfuric acid bath (Industrial Chemical and Equipment Co., Minneapolis, MN) at approximately 20 A/ft². The ink was then stripped by dipping for 30 sec in an aqueous bath containing 1% NaOH and 0.1% Neodol 25-7 non-ionic surfactant composed of a hydrocarbon tail grafted to an ethylene glycol oligomer (available from Shell Oil Co.) at 62°C. The sample was brushed lightly and rinsed with water.

The copper was etched in the areas where the resist pattern was present by dipping it in an aqueous solution containing 10% sulfuric acid and 3% hydrogen peroxide and agitating gently for 30 sec until clear PET was visible. Lines of 25 μ m width and 51 μ m pitch were demonstrated to be feasible with this method.

Example 3

Acetylene dicarboxylic acid (1.0 g) was added to a solution of 40 g MEK and 9.0 g bis(azidomethyl)oxetane ("BAMO") and heated to 50°C for 10 hours. This material was either used in the MEK solution or it was prepared in an aqueous solvent. A 33.3 g portion of the MEK solution was concentrated on a rotary evaporator to give a viscous semi-solid (less than 3% residual solvent), and redissolved in a mixture of 1.8 g ethanolamine, 44 g isopropyl alcohol, and 88 g water at 40°C.

A dispersion was prepared by mixing (3.22g) bis(azidomethyl)oxetane ("BAMO")/(10g) acetylenedicarboxylic acid ("AD") (prepared as disclosed in the preceding paragraph) 8% solids in 1:2 isopropyl alcohol (IPA)/H₂O with (0.28g) Aquis Carbon Black 47% solids (available from Heucotech LTD 99, Failless Hills, PA.). Six drops of a fluorochemical surfactant, available under the trade designation Fluorad FC 170 from 3M Co., St. Paul, MN, diluted to 5% in 50/50 IPA/H₂O vol % was added to the dispersion. This mixture was coated onto a 2 mil polypropylene film (donor) with a #10 Mayer bar and then air dried.

Daratak 90L adhesive, was diluted to 5.5% solids with a mixture of 2:1 IPA/MEK. It was then coated over the top of the BAMO/AD/carbon black dispersion on the 2 mil polypropylene film with a #10 Mayer bar. This was then dried for five minutes in a 50°C oven.

The receptor was a polyester (PET) film that was vapor coated with a nickel layer and a thin seed layer of copper. A 0.002 inch thick biaxially-oriented PET containing slip agent on the opposite side of the vapor coating was metallized with approximately 5 nm Inconel 600 sputtered on the PET, approximately 75 nm Cu evaporated on the Inconel 600.

The receptor and the donor were placed on a porous ceramic vacuum hold down, facing each other with the donor sheet on top and a vacuum was then applied. A glass mask was placed on top of the donor and then exposed to the output of a short pulse flash lamp system. The linear flash lamps used were constructed of Suprasil quartz tubing with a bore of 0.4 cm and a spacing of 63.5 cm between the electrodes. The lamps were filled with Xenon at a pressure of 200 torr. The flash lamp was mounted in a cusp-shaped reflector coated with a high ultraviolet reflectivity (Acton Research Corporation, coating number 2500). The cusp reflector had a length of approximately 64 cm and a width of 5 cm. The flash lamp system was operated in the simmered mode (2.0 A simmer current). The pulse width of the high energy pulse (FWHM of the current waveform) was 4.5 μ sec. A pulse energy of 200 Joules/pulse was used for all samples. The BAMO/carbon black dispersion was blown off the donor sheet onto the unmasked areas of the receptor forming good circuit patterns.

A copper circuit pattern was achieved using two different procedures. The first procedure started with the substrate for the receiving element containing the resist pattern on it. An additional 2-5 μ m of copper was electroplated onto the vapor-coated seed using a standard printed circuit board sulfuric acid bath (as supplied by Industrial Chemical and Equipment Co., Minneapolis, MN). 2-5 μ m of copper was plated using a plating current density of 20 A/ft². The carbon black/adhesive was stripped off using an aqueous 45°C sodium hydroxide solution (1%) containing Neodol 25-7 surfactant. The vapor coated seed layer was removed using a chemical etch composed of 5% sulfuric acid and 5% hydrogen peroxide in distilled water. A 2-5 μ m thick copper pattern was left in the electroplated areas. In the second procedure, the receptor with the transferred pattern was placed directly into the sulfuric acid/hydrogen peroxide solution and

the vapor-coated seed layer was removed in the unpatterned areas. The resist was removed using the sodium hydroxide solution, leaving a pattern of thin copper. A thicker layer of imaged copper could be produced by using the desired thickness of copper as the receptor substrate for imaging.

- 5 Reasonable variations and modifications are possible from the foregoing disclosure without departing from either the spirit or scope of the present invention as defined in the claims.

WHAT IS CLAIMED IS:

1. A process for preparing printed circuits comprising the steps of:
 - (a) imagewise exposing a donor element comprising a substrate having
5 coated thereon a resist material comprising a light-to-heat
converter dispersed in a binder to a source of electromagnetic
radiation under conditions sufficient to transfer said resist material
from said donor element to a metal-coated surface of a receiving
element;
 - 10 (b) etching the exposed metal surface of said receiving element; and
 - (c) removing the resist material from said receiving element.
2. The process according to Claim 1 wherein said resist material is
thermally transferred from said donor element to said receiving element.
15
3. The process according to Claim 1 wherein the source of said
electromagnetic radiation is a laser.
4. The process according to Claim 1 wherein said source of
20 electromagnetic radiation is a flash lamp.
5. The process according to Claim 4 wherein said binder of said resist
material comprises an acrylic resin.
- 25 6. The process according to Claim 4 wherein said binder of said resist
material comprises a gas-producing polymer.
7. The process according to Claim 1 wherein said resist material in
step (a) further comprises an adhesive topcoat.

8. A process for preparing printed circuits comprising the steps of:
- 5 (a) imagewise exposing a donor element comprising a substrate having coated thereon a resist material comprising a light-to-heat converter dispersed in a binder to a source of electromagnetic radiation under conditions sufficient to transfer said resist material from said donor element to a thin metal-coated surface of a receiving element;
- (b) metal plating the exposed metal surface of said receiving element;
- 10 (c) removing said resist material from said receiving element; and
- (d) etching away the areas of the thin metal-coated surface where said resist was present before removal from said receiving element.
9. The process according to Claim 8 wherein said resist material is thermally transferred from said donor element to said receiving element.
- 15 10. The process according to Claim 8 wherein said source of electromagnetic radiation is a laser.
11. The process according to Claim 8 wherein said source of electromagnetic radiation is a flash lamp.
- 20 12. The process according to Claim 8 wherein said binder of said resist material comprises an acrylic resin.
13. The process according to Claim 8 wherein said binder of said resist material comprises a gas-producing polymer.
- 25 14. The process according to Claim 8 wherein said resist material in step (a) further comprises an adhesive topcoat.

INTERNATIONAL SEARCH REPORT

National Application No
PCT/US 96/15944

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H05K3/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Week 8642 Derwent Publications Ltd., London, GB; AN 86-27650	

INTERNATIONAL SEARCH REPORT

International Application No
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C(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Week 8632 Derwent Publications Ltd., London, GB; AN 86-209916 XP002022153 & JP,A,61 144 092 (DAICEL CHEM IND KK) , 1 July 1986 see title	1-3
A	--- PATENT ABSTRACTS OF JAPAN vol. 14, no. 99 (E-0893), 22 February 1990 & JP,A,01 303786 (SHIKOKU CHEM CORP), 7 December 1989, see abstract	1,2
A	--- PATENT ABSTRACTS OF JAPAN vol. 17, no. 103 (M-1374), 2 March 1993 & JP,A,04 292993 (TOPPAN PRINTING CO), 16 October 1992, see abstract -----	1,2,7

